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1. Title of the invention
Manufacturing method for condensed carbon dioxide containing ozone

2. Inventor
Nobuhiko OKADA (and 2 others) [seal illegible]
3-188 Gakuen-Daiwa-chō, Nara-shi

3. Patent applicant
Representative Director Iwao NISHIYAMA
Osaka Gas Co., Ltd.
5-1 Hiranomachi, Higashi-ku, Ōsaka-shi

4. Agent
(5685) Patent attorney Hachirō SAEGUSA (and 2 others)
Heiwa Bldg., 2-10 Hiranomachi, Higashi-ku, Ōsaka-shi
Telephone: Osaka (203) 0941 [seal illegible]

5. List of attachments

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SPECIFICATION

TITLE OF THE INVENTION

Manufacturing method for condensed carbon dioxide containing ozone

SCOPE OF PATENT CLAIMS

1. A manufacturing method for condensed carbon dioxide containing ozone characterized in that liquid carbon dioxide is dissolved in ozone or liquid carbon dioxide containing ozone is solidified by cooling.

DETAILED DESCRIPTION OF THE INVENTION

This invention relates to a manufacturing method for condensed carbon dioxide containing ozone.

Due to its superior bactericidal, deodorizing, decoloring, and other properties based on its powerful oxidation capability, ozone has recently become the unexpected focus of much attention as a very useful substance with a view to the purification of tap water and sewerage and other treatment of polluting waste materials, the preservation of foodstuffs, as well as bleaching, decoloring, deodorizing, oxidation acceleration, fermentation acceleration, oxidation treatment, and the like across a wide range of industrial fields, apart from solutions to environmental problems. However, given that it is difficult to obtain high concentrations of ozone and to safely store and transport it due to its decomposability, the current reality is that its scope of use is very limited.

For this reason, attempts are already being made to conduct storage and transport of ozone in a state where it is uniformly dissolved in liquefied freon. Ozone is certainly stable and comports no risk of decomposing in the state where it is dissolved in freon, but as a portion of the freon is gasified together with ozone at the time of use, there is the difficulty that it cannot be used in the preservation of foodstuffs and in specific industrial fields, and furthermore, as freon is expensive, there are many fields where use is prohibitive due to cost. For these and other reasons, its scope of use still remains very limited.

The present inventors compiled a variety of research with a view to establishing a new method for safely and easily conducting storage and transport of highly concentrated ozone, but the dissolvability, etc. of ozone relative to conventional low-temperature liquefied gases *was* entirely unclear. However, as a result of the research of the present inventors, it was discovered that carbon dioxide (hereinafter referred 3 to as carbon *gas*) possesses a high degree of dissolvability relative to ozone, and can be very

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safely stored and transported, and this invention was finally perfected after further progress in research.

Below, this invention is explained in detail by means of an embodiment shown in the attached drawing.

The raw material, such as liquid or gaseous oxygen, gas containing oxygen-like air, or a liquefied substance thereof, supplied via a pump (2) from a suitable tank (1), is transformed into ozone in an ozone generator (3) by electric discharge, exposure to radiation, exposure to ultrasonic waves, exposure to ultraviolet rays, or the like, or by combinations of these. Next, the gas containing the generated ozone is blown into an ozone absorption chamber (5) by a compressor (4), and preferably into liquid carbon gas (6) stored at the bottom of the pertinent ozone absorption chamber (5). In this case, it is desirable to have cooled in advance the gas containing the ozone to a temperature at or below that of the liquid carbon gas (6). In the case where the pressure inside the ozone generator (3) is higher than the pressure in the ozone absorption chamber (5), there is no need to install the compressor (4), and the gas containing the ozone is instead supplied to the ozone absorption chamber (5) by adjusting the pressure of this gas. Apart from the blowing method mentioned above, ozone absorption into the liquid carbon gas in the ozone absorption chamber (5) may be accomplished by methods such as the membrane flow method and the stirring method.

With regard to operating conditions in the ozone absorption chamber (5), it is indispensable to have a temperature range between 31.0°C and −56.6°C in a pressure range at or above 5.3 ata at the triple point of carbon gas. The ozone concentration in liquid carbon gas may be subjected to various adjustments as necessary, but as there is a risk that the high concentration phase may cause an explosion if concentration is excessive, it is preferable to set the ceiling at approximately 25 mol%.

The carbon containing ozone that has collected at the bottom of the ozone absorption chamber (5) by the aforementioned process is continuously supplied to the storage container (7). If necessary, it is further sent to a cooling process, where the carbon containing ozone is solidified by cooling at a temperature and pressure at which it can maintain solidity, and becomes solid carbon containing ozone (dry ice). This dry ice may also be returned to atmospheric pressure while being kept at or below the sublimation temperature.

The oxygen or unreacted oxygen produced in the ozone absorption chamber (5) by ozone decomposition is again sent to the ozone generator (3) via the pressure-regulating and counter-flow check valve (8). In this case, it is acceptable to send this oxygen to the ozone generator (3) after removing the carbon gas by an alkaline absorption device or other carbon gas removal device (not illustrated) if necessary.

The condensed carbon gas containing ozone obtained in the foregoing manner is used to generate ozone by a method such as increasing temperature or decreasing pressure (for example, in the case of liquid carbon gas containing ozone, this is discharged from a nozzle).

Not only is the condensed carbon gas containing ozone obtained by the method of this invention low in manufacturing cost, and able to produce a very high ozone concentration of approximately 25 mol%, but it can also be very safely and easily transported. It thereby enables a dramatic expansion in the scope of use of ozone, which has heretofore been subject to a variety of restrictions. That is, it can be used for resolving tap water and sewerage purification and other pollution problems, and for a great variety of purposes such as decoloring, sterilization, bleaching, deodorizing, oxidation treatment, and oxidation reactions in a wide range of industrial fields due to ozone's uniquely powerful oxidizing capability. In addition, one can also develop a wide range of applications that have previously been completely overlooked, such as new applications derived from the coexistence of carbon gas and ozone, e.g., atmospheric gas for C.A. storage of various types of fruits, vegetables, grains, and the like, manufacture of carbonated beverages omitting the sterilization process, general use in households, and treatments for decoloring, sterilization, bleaching, deodorizing and so on.

Below, the characteristics of this invention are further clarified by an example of embodiment.

Example of Embodiment

50 ℓ of carbon gas (STP) are introduced into a pressure-resistant container cooled to −40 to −45°C at a pressure of 9.2 kg/cm^2G, and liquefied in advance. Next, the ozone generated in an electric discharge tube-type ozone generator containing 2% oxygen is compressed at 9.5 kg/cm^2G and −45°C, cooled, and fed into the liquid carbon gas in the aforementioned pressure-resistant container at a rate of 1.2 ℓ/min (STP), where the ozone is absorbed.

The unabsorbed oxygen, ozone, and evaporated carbon gas are discharged to the outside of the container by a relief valve. Next, 50 ml of the liquid carbon gas containing 5 vol% of ozone obtained in this way is sent to another pressure-resistant container, cooled by a dry ice–ether freezing mixture, and solidified, after which the pressure in the container is gradually reduced, and returned to atmospheric pressure to obtain 72 g of dry ice containing 3.5 g of the ozone.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing shows a flowchart of one embodiment of this invention.

(1) tank for oxygen or a gas containing oxygen or oxides of these, (2) pump, (3) ozone generator, (4) compressor, (5) ozone absorption chamber, (6) liquid carbon gas, (7) storage container for liquid carbon gas containing ozone, (8) pressure-regulating and counter-flow check valve.

(END)

Agent: Patent attorney Hachirō SAEGUSA
(and 2 others) [seal illegible]

[see source for figure]

6. Inventors and agents other than the aforementioned

(1) Inventors

Yusuke SAKAMOTO
13 Jūniken-chō, Higashi-ku, Ōsaka-shi
[seal illegible]
Yoshihiro SATO
1-7-19 Wakakusa-chō, Nishnomiya-shi

(2) Agents

(6250) Patent attorney Nobuhiro HOSAKA
[seal: Seal of Patent Attorney Nobuhiro HOSAKA]
Heiwa Bldg., 2-10 Hiranomachi, Higashi-ku, Ōsaka-shi

(6521) Patent attorney Eiji SAEGUSA
[seal: Seal of Patent attorney Eiji SAEGUSA]
Same address as above